Supplementary Appendix 2

Biasing effect of sampling strategy for the gamma-ray survey and role of classical measurement error

In this Appendix we consider the potential biasing effect of the sampling strategy adopted in the National Survey to measure gamma-ray doses. There are on average about 5 measurement points in each CD, the average of which is applied to all persons resident in the CD. If sampling points were chosen at random from the population, and the measurements in each CD are independent and have the same distribution, then Berkson error results, which does not bias the dose-response [1]. However, although the original sample of measurement addresses was unbiased, measurements were completed in only 50% of dwellings, with a disproportionate number responding from higher socioeconomic groups. Nevertheless, for gamma-ray measurements there is no clear socioeconomic gradient in the levels [2]. Taking into account the proportions of persons living in houses of various types [2], which provide an indication of socioeconomic status, the mean predicted gamma-ray dose-rate given by the National Survey would be 59.90 nGy/h, whereas if the distribution of house types were that of the General Household Survey [3] it would be 59.87 nGy/h. It therefore appears that the bias in gamma-ray dose-rates from this source is negligible.

There may also be a component of classical measurement error, resulting from inaccuracies in the gamma-ray dosemeter measurements. Classical dose measurement error would be expected to result in biasing of trends towards the null by a factor $\sigma_X{}^2/[\sigma_X{}^2+\sigma_U{}^2]$, where the standard deviation (SD) of the error in the dosemeter is σ_U, and the SD of the true gamma-ray dose distribution is σ_X [1]. The gamma-ray dosemeters used in the study have been compared in an international standardisation exercise, and the agreement of the mean of all the dosemeters at each environmental site was generally better than 5% [2], implying that the ratio of SDs is small -

probably $\sigma_U / \sigma_X \leq 0.05$. Therefore the bias factor, $\sigma_X{}^2 / [\sigma_X{}^2 + \sigma_U{}^2]$, is within 1% of unity, implying minimal dose-response bias.

Reference List

1 Carroll RC, Ruppert D, Stefanski LA, Crainiceanu CM. *Measurement Error in Nonlinear Models: A Modern Perspective*. Second edition ed. Chapman and Hall/CRC: Boca Raton, 2006.

2 Wrixon AD, Green BMR, Lomas PR, Miles JCH, Cliff KD, Francis EA *et al*. Natural radiation exposure in UK dwellings. National Radiological Protection Board: Chilton,Didcot,Oxon, 1998. Report No: NRPB-R190.

3 Office of Population Censuses & Surveys. *General Household Survey 1982 An Inter-Departmental Survey Sponsered by the Central Statistical Office*. HMSO: London, 1984.